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(54) Detergent compositions containing ethoxylated amines having clay soil removal/anti-redeposition properties.

(57) Water-soluble ethoxylated amine compounds having clay soil removal/anti-redeposition properties. The compounds are selected from ethoxylated diamine compounds, ethoxylated polyamines and mixtures thereof. These ethoxylated amine compounds are useful in detergent compositions.

Detergent compositions which comprise from about 0.05 to about 95% by weight of a water-soluble ethoxylated amine having clay soil removal/anti-redeposition properties. These compounds are selected from ethoxylated monoamines, ethoxylated diamines, ethoxylated polyamines, ethoxylated amine polymers and mixtures thereof. In addition to the ethoxylated amines, the detergent compositions further comprise from about 1 to about 75% by weight of a nonionic, anionic, ampholytic, zwitterionic or cationic detergent surfactant, or mixture thereof. In addition to these detergent surfactants, the detergent composition can optionally comprise from 0 to about 80% by weight of a detergent builder.

ACTORIUM AG

DETERGENT COMPOSITIONS CONTAINING ETHOXYLATED AMINES
HAVING CLAY SOIL REMOVAL/ANTI-REDEPOSITION PROPERTIES

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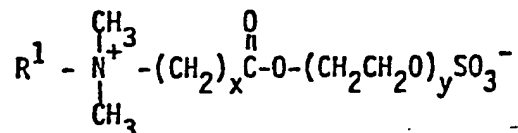
Eugene Paul Gosselink

The present application relates to ethoxylated amines having clay-soil removal/anti-redeposition properties when used in detergent compositions.

10 A particularly important property of a detergent composition is its ability to remove particulate type soils from a variety of fabrics during laundering. Perhaps the most important particulate soils are the clay-type soils. Clay soil particles generally comprise negatively charged layers of aluminosilicates and positively charged cations (e.g. calcium) which are positioned between
15 and hold together the negatively charged layers.

A variety of models can be proposed for compounds which would have clay soil removal properties. One model requires that the compound have two distinct characteristics. The first is the ability of the compound to adsorb onto the negatively-charged
20 layers of the clay particle. The second is the ability of the compound, once adsorbed, to push apart (swell) the negatively charged layers so that the clay particle loses its cohesive force and can be removed in the wash water.

25 One class of clay-soil removal compounds which appears to work according to this model are the polyethoxy zwitterionic surfactants disclosed in U.S. Patent 4,301,044 to Wentler et al., issued November 17, 1981. Representative of such compounds are those having the formula:



30 wherein R^1 is a C_{14} - C_{20} alkyl group; x is 1 or an integer of from 3 to 5; and y is from 6 to 12. See also U.S. Patent 3,929,678 to Laughlin et al., issued December 30, 1975 (detergent composition containing polyethoxy zwitterionic surfactant plus other detergent

surfactants); U.S. Patent 3,925,262 to Laughlin et al., issued December 9, 1975 (detergent composition containing polyethoxy zwitterionic surfactants with detergent builders); U.S. Patent 4,157,277 to Gosselink et al., issued June 26, 1979 (C₄ polyoxy-alkylene zwitterionic surfactants useful in detergent compositions); U.S. Patent 4,165,334 to Gosselink et al., issued August 21, 1979 (sulfonium-type polyethoxy zwitterionic surfactants).

These polyethoxy zwitterionic surfactants are generally compatible with other detergent surfactants such as the nonionic, zwitterionic and ampholytic types. However, as indicated in the Wentler et al. patent, most anionic surfactants interfere with the particulate soil removal performance of these compounds; anionic soils such as fatty acids likewise interfere. Because anionic detergent surfactants form the most important class of such materials for use in detergent compositions, the lack of compatibility between these polyethoxy zwitterionic surfactants and anionic surfactants poses a significant handicap where particulate (clay) soil removal is desired.

In addition to clay soil removal, one of the other properties mentioned in the Laughlin et al. patents with regard to these polyethoxy zwitterionic surfactants is the ability to keep the removed soil in suspension during the laundering cycle. Soil which is removed from the fabric and suspended in the wash water can redeposit onto the surface of the fabric. This redeposited soil causes a dulling or "graying" effect which is especially noticeable on white fabrics. Because soil is normally hydrophobic, this graying effect is a particularly important problem for those fabrics made in total or in part from hydrophobic fibers, e.g. polyester.

To minimize this problem, anti-redeposition or whiteness maintenance agents can be included in the detergent composition. Besides the previously mentioned polyethoxy zwitterionic surfactants, there are a variety of other compounds which can be used as anti-redeposition agents. One class of agents are the water-soluble copolymers of acrylic or methacrylic acid with acrylic or methacrylic acid-ethylene oxide condensates disclosed in U.S.

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Patent 3,719,647 to Hardy et al., issued March 6, 1973. Another class of anti-redeposition agents are the cellulose and carboxymethylcellulose derivatives disclosed in U.S. Patent 3,597,416 to Diehl, issued August 3, 1971 (ionic combination of dodecyltrimethyl phosphonium chloride and sodium carboxymethylcellulose), and U.S. Patent 3,523,088 to Dean et al., issued August 4, 1970 (anti-redeposition agent consisting of alkali metal carboxymethylcellulose and hydroxypropylcellulose). A mixture of compounds has also been used to provide not only anti-redeposition, but also clay soil removal properties. See U.S. Patent 4,228,044 to Cambre, issued October 14, 1980, which discloses detergent compositions having anti-redeposition and clay soil removal properties which can comprise a nonionic alkyl polyethoxy surfactant, a polyethoxy alkyl quaternary cationic surfactant and a fatty amide surfactant.

These anti-redeposition agents do have a number of significant handicaps. While effective to keep soil suspended, these compounds may lack additional clay soil removal properties. Moreover, as disclosed in the Diehl and Dean et al. patents, mixtures of compounds can be required to achieve the anti-redeposition benefit. To the extent that there are combined anti-redeposition/clay soil removal benefits as disclosed in the Cambre patent, mixtures of compounds are also required.

It is therefore an object of the present invention to provide compounds useful in detergent compositions which provide particulate soil, in particular clay soil, removal benefits.

It is a further object of the present invention to provide compounds useful in detergent compositions which provide clay soil removal benefits and are anionic detergent surfactant compatible.

It is yet another object of the present invention to provide compounds useful in detergent compositions having anti-redeposition properties.

It is yet a further object of the present invention to provide compounds useful in detergent compositions which combine both clay soil removal and anti-redeposition properties.

These and further objects of the present invention are hereinafter disclosed.

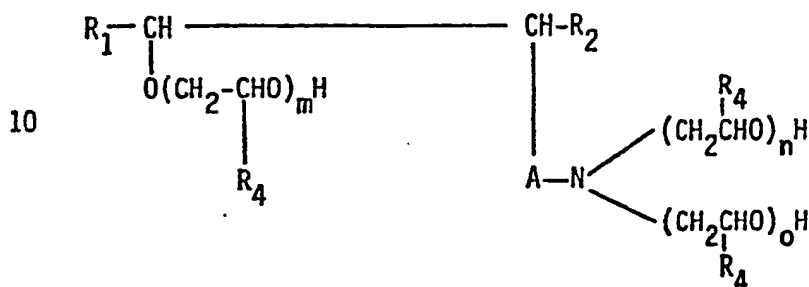
BACKGROUND ART

5 U. S. Patent 3,301,783 to Dickson, et al., issued January 31, 1967, discloses oxyalkylated, acylated, alkylated, carbonylated and olefinated derivatives of polyalkyleneimines, in particular polyethyleneimines (PEIs). For the oxyalkylated derivatives, the alkylene oxide (e.g. ethylene oxide) is reacted with the poly-
10 alkyleneimine in a mole ratio of from 1:1 to 1000:1, and preferably in a ratio of from 1:1 to 200:1. Among the ethoxylated PEIs disclosed are Examples 1-0₇ and 1-0₈ formed by condensing 105 and 200 moles, respectively, of ethylene oxide with a 900 M.W. PEI. The degree of ethoxylation calculates out to about 4.5 and about 8
15 ethoxy groups per reactive site, respectively. See also Examples 27-0₅ and 27-0₆ which disclose ethoxylated polypropyleneimines (M.W. 500) which have about 4 and about 8 ethoxy units per reactive site, respectively. Amongst the numerous disclosed uses of these polyalkyleneimine derivatives is a teaching that they are
20 useful as detergents, softening agents, and anti-static agents. Preferred uses disclosed by this patent are as chelating agents, lubricating oil additives, emulsifying agents, and cutting oils.

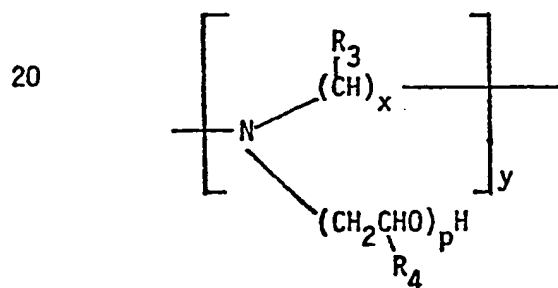
U.S. Patent 2,792,371 to Dickson, issued May 14, 1957, teaches a process for breaking petroleum emulsions with oxy-
25 alkylated tetraethylene pentaamines (TEPA). Ethoxylated TEPA's specifically disclosed include those having about 5 (Example 3aa), about 7 (Example 4aa), about 8.5 (Example 5a) and about 15.5 (Example Bc) ethoxy units per reactive site. Similarly, U.S. patent 2,792,370 to Dickson issued May 14, 1957, teaches a process
30 for breaking petroleum emulsions with oxyalkylated triethylene tetramines (TETAs) including those having about 5.5 (Example 3aa), about 7.5 (Example 4aa), about 9 (Example 5a) and about 16.5 (Example Bc) ethoxy units per reactive site. See also U. S. patent 2,792,372 to Dickson, issued May 14, 1957, (oxyalkylated
35 higher PEAs used to break petroleum emulsions); U. S. patent

2,792,369 to Dickson, issued May 14, 1957 (oxyalkylated diethylene triamines used to break petroleum emulsions).

U. S. Patent 4,171,278 to Andree et al., issued October 16, 1979, discloses cold water detergent compositions containing a
 5 detergent surfactant (e.g. anionic) and a hydroxyalkyl amine in a weight ratio of 100:1 to 1:1. The amine can have the formula:



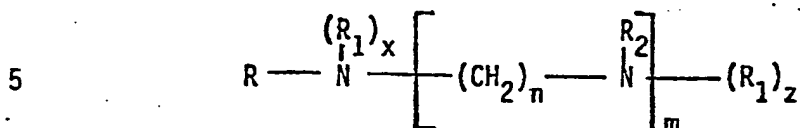
15 wherein R_1 is $\text{C}_1\text{-C}_{16}$ alkyl; R_2 is H or $\text{C}_1\text{-C}_{16}$ alkyl; $\text{R}_1 + \text{R}_2$ have 6-20 carbon atoms; R_4 is H or methyl; m, n, and o, are each 0 to 3 and A is bridging group such as



25 wherein R_3 is H or methyl; x is 2 to 6; y is 1 to 3; and p is 0 to 3; the sum of m to p being 1 to 5.5, and preferably 1 to 2. See also German Patent Document 2,165,900 to Henkel, published July 5, 1973, which discloses a washing agent for graying prevention
 30 formed by the reaction product of a PEI with an alkylglycidylether and ethylene oxide (2-hydroxyethyl moiety at each reactive site when ethoxylated).

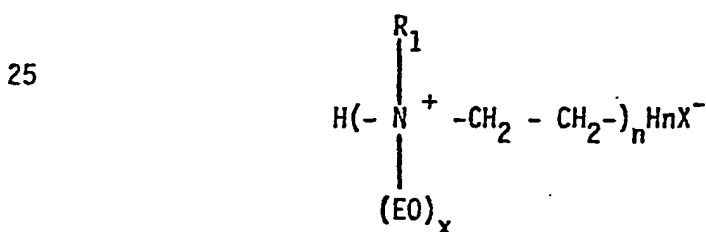
European Patent Application 42,187 to Koster, published
 December 23, 1981, discloses detergent compositions having en-
 35 hanced soil release and cleaning properties. These compositions contain from about 2% to about 60% by weight of a detergent

surfactant (e. g. anionic) and from 0.1% to 1.2% by weight of a polyamine. This polyamine has the formula:



wherein R is a C₁₀ to C₂₂ alkyl or alkenyl group; R₁ is ethylene-oxide/propylene oxide; R₂ can be (R₁)_y; x, y, and z are numbers
 10 such that their sum is from 2 to about 25; n is from 1 to about 6; and m is from 1 to about 9. Preferred polyamines are those where R₁ is ethylene oxide, R₂ is ethylene oxide, n is 2 or 3, m is 1 to 3, and x, y, z, are each 1 to 4 with their sum being from 3 to 18. Examples 6 and 7 disclose ethoxylated N-hydrogenated tallow-
 15 propylene - 1,3-diamines, where the sum of x, y, and z are 7 and 12, respectively.

U. S. Patent 3,838,057 to Barnes et al., issued September 24, 1974, discloses toilet bars containing ethoxylated quaternary ammonium compounds, including ethoxylated, quaternized PEIs taught
 20 to be useful in the detergent, textile, and polymer industries, as anti-static and softening agents. These ethoxylated quaternized PEIs have the formula:



30 wherein R₁ is a compatible quaternary nitrogen substituent; n is at least 2; x is from 3 to 40; and X⁻ is a compatible anion. Preferred compounds are those where R₁ is a C₈ - C₂₂ alkyl group or the group:



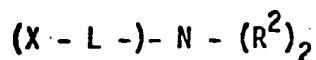
where R' is a C₈ - C₂₂ alkyl group and y is from 3 to 40. See also U. S. Patent 4,179,382 to Rudkin et al., issued December 18, 1979; U. S. Patent 4,152,272 to Young, issued May 1, 1979; and European Patent Application 2,085 to Rudkin et al., published May 30, 1979, which disclose ethoxylated quaternized polyamines having C₁₀ to C₂₄ alkyl or alkenyl groups attached to one of the nitrogen atoms useful as fabric softeners.

There are several patents which disclose detergent compositions, shampoo compositions and the like containing slightly ethoxylated PEIs (ethylene oxide:PEI weight ratio of 4:1 or less) to enhance the deposition and retention of particulate substances such as antimicrobials. See, for example, U. S. Patent 3,489,686 to Parran, issued January 13, 1970; U. S. Patent 3,580,853 to Parran, issued May 25, 1971; British Patent Specification 1,111,708 to Procter & Gamble published May 1, 1968, U.S. Patent 3,549,546 to Moore, issued December 22, 1970; and U.S. Patent 3,549,542 to Holderby, issued December 22, 1970.

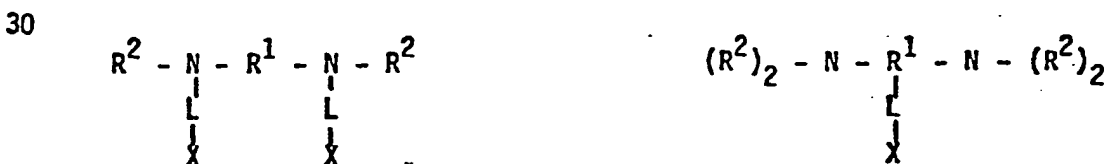
DISCLOSURE OF THE INVENTION

The present invention relates to detergent compositions which comprise from about 0.05 to about 95% by weight of water-soluble ethoxylated amines having clay soil removal/ anti-redeposition properties. These compounds are selected from the group consisting of:

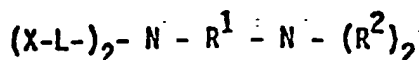
(1) ethoxylated monoamines having the formula:



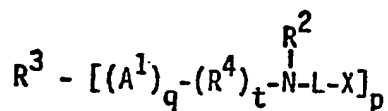
(2) ethoxylated diamines having the formula:



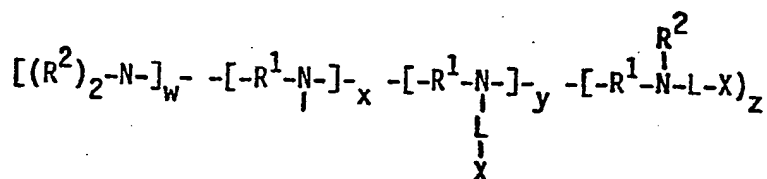
or



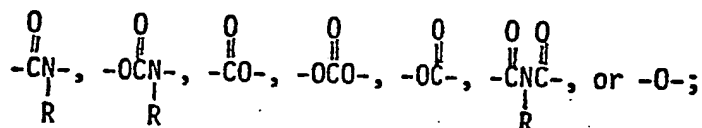
(3) ethoxylated polyamines having the formula:



(4) ethoxylated amine polymers having the general formula:



and (5) mixtures thereof; wherein A^1 is $\overset{\overset{O}{||}}{NC-}$, $\overset{\overset{O}{||}}{NCO-}$, $\overset{\overset{O}{||}}{N} \overset{\overset{O}{||}}{CN-}$,



R is H or C_1 - C_4 alkyl or hydroxyalkyl; R^1 is C_2 - C_{12} alkylene, hydroxyalkylene, alkenylene, arylene or alkarylene, or a C_2 - C_3 oxyalkylene moiety having from 2 to about 20 oxyalkylene units provided that no O-N bonds are formed; each R^2 is C_1 - C_4 alkyl or hydroxyalkyl, the moiety $-L-X$, or two R^2 together form the moiety $-(CH_2)_r - A^2 - (CH_2)_s -$, wherein A^2 is $-O-$ or $-CH_2-$, r is 1 or 2, s is 1 or 2, and $r + s$ is 3 or 4; X is a nonionic group, an anionic group or mixture thereof; R^3 is a substituted C_3 - C_{12} alkyl, hydroxyalkyl, alkenyl, aryl, or alkaryl group having p substitution sites; R^4 is C_1 - C_{12} alkylene, hydroxyalkylene, alkenylene, arylene or alkarylene, or a C_2 - C_3 oxyalkylene moiety have from 2 to about 20 oxyalkylene units provided that no O-O or O-N bonds are formed; L is a hydrophilic chain which contains the polyoxyalkylene moiety $-[(R^5O)_m(CH_2CH_2O)_n]-$, wherein R^5 is C_3 - C_4 alkylene or hydroxyalkylene and m and n are numbers such that the moiety $-(CH_2CH_2O)_n-$ comprises at least about 50% by weight of said polyoxyalkylene moiety; for said

monoamines, m is from 0 to about 4, and n is at least about 12; for said diamines, m is from 0 to about 3, and n is at least about 6 when R¹ is C₂-C₃ alkylene, hydroxyalkylene, or alkenylene, and at least about 3 when R¹ is other than C₂-C₃ alkylene, hydroxyalkylene or alkenylene; for said polyamines and amine polymers, m is from 0 to about 10 and n is at least about 3; p is from 3 to 8; q is 1 or 0; t is 1 or 0, provided that t is 1 when q is 1; w is 1 or 0; x + y + z is at least 2; and y + z is at least 2.

10 In addition to the ethoxylated amines, the detergent compositions further comprise from about 1 to about 75% by weight of a nonionic, anionic, ampholytic, zwitterionic or cationic detergent surfactant or mixture thereof. In addition to these detergent surfactants, the detergent composition can optionally comprise
15 from 0 to about 80% by weight of a detergent builder.

The ethoxylated amines of the present invention provide clay soil removal benefits while being anionic detergent surfactant compatible. At most wash pH's, it is believed that the nitrogen atoms of these compounds are partially protonated. The resulting
20 positively charged centers (and remaining polar nitrogen atoms) are believed to aid in the adsorption of the compound onto the negatively charged layers of the clay particle. It is also believed that the hydrophilic ethoxy units of the compound swell the clay particle so that it loses its cohesive character and is
25 swept away in the wash water.

The anti-redeposition benefits provided by these ethoxylated amines are also believed to be due to the formation of positively charged centers which, together with the remaining polar nitrogens, aid in its adsorption onto soil suspended in the wash
30 water. As more and more of these compounds adsorb onto the suspended soil, it becomes encased within a hydrophilic layer provided by the attached ethoxy units. As such, the hydrophilically encased soil is prevented from redepositing on fabrics, in particular hydrophobic fabrics such as polyester, during the
35 laundering cycle.

Ethoxylated Amines

The water-soluble ethoxylated amines useful in detergent compositions of the present invention are selected from ethoxylated monoamines, ethoxylated diamines, ethoxylated polyamines, ethoxylated amine polymers, and mixtures thereof as previously defined.

In the preceding formulas, R^1 can be branched

(e.g. $-\text{CH}_2-\underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{CH}}}-$, $-\text{CH}_2-\underset{\text{O}}{\overset{\text{O}}{\text{CH}}}-$), cyclic (e.g. $-\text{C}_6\text{H}_{10}-$),

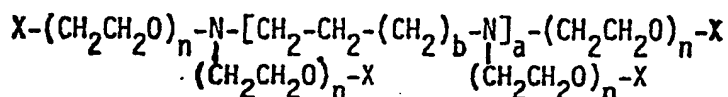
or most preferably linear (e.g. $-\text{CH}_2\text{CH}_2-$, $-\text{CH}_2-\underset{\text{O}}{\overset{\text{O}}{\text{CH}}}-\text{CH}_2-$,

$-\text{CH}_2-\underset{\text{O}}{\overset{\text{O}}{\text{CH}}}-$) alkylene, hydroxyalkylene, alkenylene, alkarylene or oxyalkylene. R^1 is preferably C_2 - C_6 alkylene for the ethoxylated diamines and amine polymers. For the ethoxylated diamines, the minimum degree of ethoxylation required for suitable clay soil removal/anti-redeposition properties decreases on going from C_2 - C_3 alkylene (ethylene, propylene) to hexamethylene. However, for the ethoxylated amine polymers, in particular the ethoxylated polyalkyleneamines and polyalkyleneimines, especially at higher molecular weights, C_2 - C_3 alkynes (ethylene, propylene) are preferred for R^1 with ethylene being most preferred. Each R^2 is preferably the moiety $-\text{L}-\text{X}$.

In the preceding formulas, hydrophilic chain L usually consists entirely of the polyoxyalkylene moiety $-\text{[(R}^5\text{O)}_m(\text{CH}_2\text{CH}_2\text{O)}_n]-$. The moieties $-(\text{R}^5\text{O)}_m-$ and $-(\text{CH}_2\text{CH}_2\text{O)}_n-$ of the polyoxyalkylene moiety can be mixed together or preferably form blocks of $-(\text{R}^5\text{O)}_m-$ and $-(\text{CH}_2\text{CH}_2\text{O)}_n-$ moieties. R^5 is preferably C_3H_6 (propylene). For the ethoxylated polyamines and amine polymers, m is preferably from 0 to about 5. For all ethoxylated amines of the present invention, m is most preferably 0, i.e. the polyoxyalkylene moiety consists entirely of the moiety $-(\text{CH}_2\text{CH}_2\text{O)}_n-$. The moiety $-(\text{CH}_2\text{CH}_2\text{O)}_n-$ preferably comprises at least about 85% by weight of the polyoxyalkylene moiety and most preferably 100% by weight (m is 0).

In the preceding formula, X can be any compatible nonionic group, anionic group or mixture thereof. Suitable nonionic groups include C_1 - C_4 alkyl or hydroxyalkyl ester or ether groups, preferably acetate or methyl ether, respectively; hydrogen (H); or mixtures thereof. The particularly preferred nonionic group is H. With regard to anionic groups, PO_3^{-2} and SO_3^- are suitable. The particularly preferred anionic group is SO_3^- . It has been found that the percentage of anionic groups relative to nonionic groups can be important to the clay soil removal/anti-redeposition properties provided by the ethoxylated amine. A mixture of from 0 to about 30% anionic groups and from about 70 to 100% nonionic groups provides preferred properties. A mixture of from about 5 to about 10% anionic groups and from about 90 to about 95% nonionic groups provides the most preferred properties. Usually, a mixture of from 0 to about 80% anionic groups and from about 20 to 100% nonionic groups provides suitable clay soil removal/anti-redeposition properties.

Preferred ethoxylated mono- and diamines have the formula:



wherein X and n are defined as before, a is 0 or 1, and b is from 0 to 4. For preferred ethoxylated monoamines ($a = 0$), n is at least about 15, with a typical range of from about 15 to about 35. For preferred ethoxylated diamines ($a = 1$), n is at least about 12 with a typical range of from about 12 to about 42.

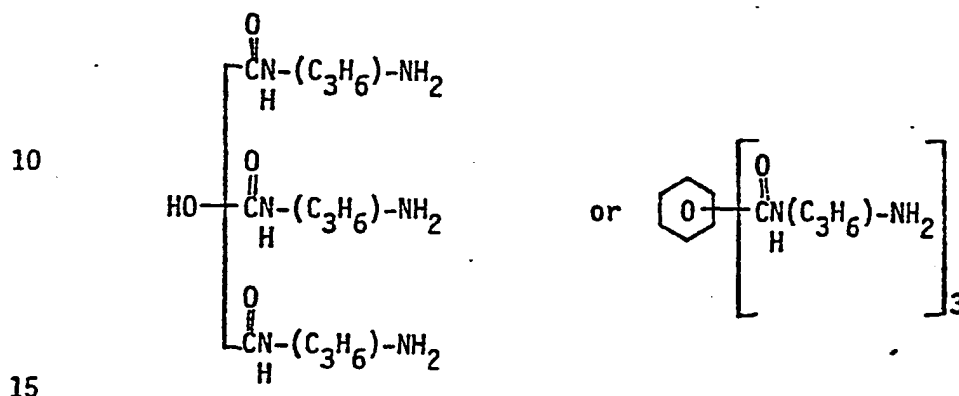
In the preceding formula for the ethoxylated polyamines, R^3 (linear, branched or cyclic) is preferably a substituted C_3 - C_6 alkyl, hydroxyalkyl or aryl group;

A^1 is preferably $\begin{array}{c} O \\ || \\ -CN- \\ H \end{array}$; n is preferably at least about 12, with a

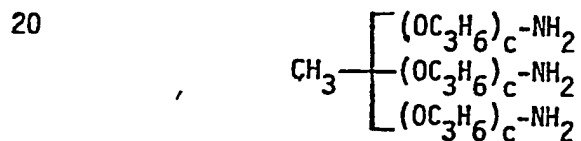
typical range of from about 12 to about 42; p is preferably from 3 to 6. When R^3 is a substituted aryl or alkaryl group, q is

preferably 1 and R^4 is preferably C_2-C_3 alkylene. When R^3 is an alkyl, hydroxyalkyl, or alkenyl group, and when q is 0, R^1 is preferably a C_2-C_3 oxyalkylene moiety; when q is 1, R^4 is preferably C_2-C_3 alkylene.

5 These ethoxylated polyamines can be derived from polyamino amides such as:



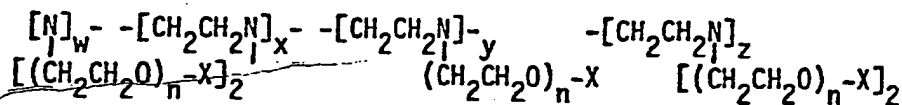
These ethoxylated polyamines can also be derived from polyamino-propyleneoxide derivatives such as:



wherein each c is a number of from 2 to about 20.

25 Preferred ethoxylated amine polymers are the ethoxylated C_2-C_3 polyalkyleneamines and polyalkyleneimines. Particularly preferred ethoxylated polyalkyleneamines and polyalkyleneimines are the ethoxylated polyethyleneamines (PEAs) and polyethyleneimines (PEIs). These preferred compounds comprise units having

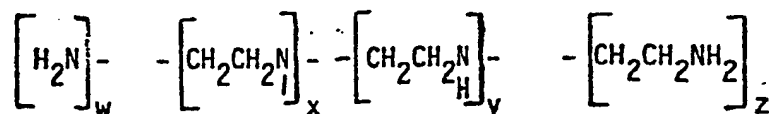
30 the general formula:



wherein X , w , x , y , z and n are defined as before.

35 Prior to ethoxylation, the PEAs used in preparing compounds of the present invention have the following general formula:

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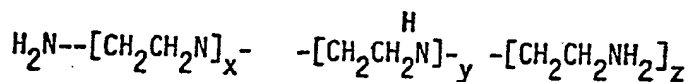


- 5 wherein $x + y + z$ is from 2 to 9, $y + z$ is from 2 to 9 and w is 0 or 1 (molecular weight of from about 100 to about 400). Each hydrogen atom attached to each nitrogen atom represents an active site for subsequent ethoxylation. For preferred PEAs, $y + z$ is from about 3 to about 7 (molecular weight of from about 140 to about 310) and most preferably from about 3 to about 4 (molecular weight of from about 140 to about 200). These PEAs can be obtained by reactions involving ammonia and ethylene dichloride, followed by fractional distillation. The common PEAs obtained are triethylenetetramine (TETA) and tetraethylenepentamine (TEPA).
- 10 Above the pentamines, i.e., the hexamines, heptamines, octamines and possibly nonamines, the cogenerically derived mixture does not appear to separate by distillation and can include other materials such as cyclic amines and particularly piperazines. There can also be present cyclic amines with side chains in which nitrogen atoms appear. See U.S. Patent 2,792,372 to Dickson, issued May 14, 1957, which describes the preparation of PEAs.

25 The minimum degree of ethoxylation required for preferred clay soil removal/anti-redeposition performance can vary depending upon the number of units in the PEA. Where $y + z$ is 2 or 3, n is preferably at least about 6. Where $y + z$ is from 4 to 9, suitable benefits are achieved when n is at least about 3. For most preferred ethoxylated PEAs, n is at least about 12 with a typical range of from about 12 to about 42.

30 The PEIs used in preparing the compounds of the present invention have a molecular weight of at least about 440 prior to ethoxylation, which represents at least about 10 units. Preferred PEIs used in preparing these compounds have a molecular weight of from about 600 to about 1800. The polymer backbone of these PEIs can be represented by the general formula:

35



- wherein the sum of x, y and z represents a number of sufficient magnitude to yield a polymer having the molecular weights previously specified. Although linear polymer backbones are possible, branch chains can also occur. The relative proportions of primary, secondary and tertiary amine groups present in the polymer can vary, depending on the manner of preparation. The distribution of amine groups is typically as follows:

$-\text{CH}_2\text{CH}_2-\text{NH}_2$	30%
$-\text{CH}_2\text{CH}_2-\text{NH}-$	40%
$-\text{CH}_2\text{CH}_2-\text{N}-$ 	30%

- Each hydrogen atom attached to each nitrogen atom of the PEI represents an active site for subsequent ethoxylation. These PEIs can be prepared, for example, by polymerizing ethyleneimine in the presence of a catalyst such as carbon dioxide, sodium bisulfite, sulfuric acid, hydrogen peroxide, hydrochloric acid, acetic acid, etc. Specific methods for preparing PEIs are disclosed in U.S. Patent 2,182,306 to Ulrich et al., issued December 5, 1939; U.S. Patent 3,033,746 to Mayle et al., issued May 8, 1962; U.S. Patent 2,208,095 to Esselmann et al., issued July 16, 1940; U.S. Patent 2,806,839 to Crowther, issued September 17, 1957; and U.S. Patent 2,553,696 to Wilson, issued May 21, 1951 (all herein incorporated by reference).

- As defined in the preceding formulas, n is at least about 3 for the ethoxylated PEIs. However, it should be noted that the minimum degree of ethoxylation required for suitable clay soil removal/anti-redeposition performance can increase as the molecular weight of the PEI increases, especially much beyond about 1800. Also, the degree of ethoxylation for preferred compounds increases as the molecular weight of the PEI increases. For PEIs having a molecular weight of at least about 600, n is preferably at least about 12, with a typical range of from about 12 to about 42. For PEIs having a molecular weight of at least 1800, n is

- 15 -

preferably at least about 24, with a typical range of from about 24 to about 42.

5 The level at which the ethoxylated amine(s) can be present in the detergent compositions of the present invention can vary depending upon the compounds used, the particular detergent formulation (liquid, granular) and the benefits desired. These compositions can be used as laundry detergents, laundry additives, and laundry pretreatments. Generally, the ethoxylated amines can be included in an amount of from about 0.05 to about 95% by weight
10 of the composition, with the usual range being from 0.1 to about 10% by weight for laundry detergents. In terms of the benefits achieved, preferred detergent compositions can comprise from about 0.5 to about 5% by weight of the ethoxylated compounds of the present invention. Typically, these preferred compositions
15 comprise from about 1 to about 3% by weight of these compounds. These compounds are normally present at a level that provides from about 2 ppm to about 200 ppm, preferably from about 10 ppm to about 100 ppm, of the compound in the wash solution at recommended U.S. usage levels, and normally from about 30 ppm to about 1000
20 ppm, preferably from about 50 ppm to about 500 ppm for European usage levels.

Methods for Making Ethoxylated Amines

The ethoxylated compounds of the present invention can be prepared by standard methods for ethoxylating amines. For the
25 diamines, polyamines, and amine polymers such as the polyalkyleneamines and polyalkyleneimines, there is preferably an initial step of condensing sufficient ethylene oxide to provide 2-hydroxyethyl groups at each reactive site (hydroxyethylation). This initial step can be omitted by starting with a 2-hydroxyethyl amine such
30 as triethanolamine (TEA). The appropriate amount of ethylene oxide is then condensed with these 2-hydroxyethylamines using an alkali metal (e.g., sodium, potassium) hydride or hydroxide as the catalyst to provide the respective ethoxylated amines. The total degree of ethoxylation per reactive site (n) can be determined
35 according to the following formula:

$$\text{Degree of Ethoxylation} = E/(A \times R)$$

wherein E is the total number of moles of ethylene oxide condensed (including hydroxyethylation), A is the number of moles of the starting amine, and R is the number of reactive sites (typically 3 for monoamines, 4 for diamines, $2 \times p$ for polyamines, and $3 + y + z$ for the amine polymers) for the starting amine.

Representative syntheses of ethoxylated amines of the present invention are as follows:

Example 1

Tetraethylenepentamine (TEPA) (M.W. 189, 61.44 g., 0.325 moles) was placed in a nominally dry flask and dried by stirring for 0.5 hours at 110°-120°C under a vacuum (pressure less than 1 mm.) The vacuum was released by drawing ethylene oxide (EO) from a prepurged trap connected to a supply tank. Once the flask was filed with EO, an outlet stopcock was carefully opened to a trap connected to an exhaust bubbler. After 3 hours stirring at 107°-115°C, 99.56 g. of EO was added to give a calculated degree of ethoxylation of 0.995. The reaction mixture was cooled while being swept with argon and 2.289 g. (0.057 moles) of 60% sodium hydride in mineral oil was then added. The stirred reaction mixture was swept with argon until hydrogen evolution ceased. EO was then added to the reaction mixture under atmospheric pressure at 109°-118°C with moderately fast stirring. After 23 hours, a total of 1503 g. (34.17 moles) of EO had been added to give a calculated total degree of ethoxylation of 15.02. The ethoxylated TEPA obtained was a tan waxy solid.

Example 2

By a procedure similar to that of Example 1, dried PEI (M.W. 600, 14.19 g., 0.0236 moles) was hydroxyethylated with EO at 130°-140°C for 3 hours with stirring. 0.5 g. (0.0125 moles) of 60% sodium hydride in mineral oil was then added and the reaction mixture swept with argon. After hydrogen evolution ceased, EO was then added under atmospheric pressure with stirring at 130°-140°C. After 14 hours, a total of 725.8 g. EO had been added to give a calculated total degree of ethoxylation of 41.5. The ethoxylated PEI 600 obtained was a tan waxy solid.

- 17 -

Example 3

By a procedure similar to that of Example 1, dried PEA (M.W. 309, 40.17 g., 0.13 moles) was hydroxyethylated with EO at 102°-118°C with stirring. After 2 hours, 54.83 g. (1.246 moles) of EO had been added for a degree of ethoxylation of 0.978. After the reaction mixture had cooled, and while being swept with argon, 1.787 g. (0.0319 moles) of freshly prepared 40% potassium hydroxide solution was added. Water was removed by stirring at 120°C under an aspirator vacuum for 0.5 hours, then under a vacuum pump for 0.5 hours. EO was then added under atmospheric pressure with stirring at 109°-130°C. After 11.5 hours, a total of 1358 g. of EO had been added to give a calculated total degree of ethoxylation of 24.2. The ethoxylated PEA 309 obtained was a tan waxy solid.

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Example 4

By a procedure similar to that of Example 1, dried triethanolamine (M.W. 149, 89.4 g. 0.6 moles) was catalyzed with 6.32 g. (0.0451 moles) of freshly prepared 40% potassium hydroxide solution under argon. Water was removed by stirring at 110°-120°C under an aspirator vacuum for 0.5 hrs., then under vacuum pump for 0.5 hrs. EO was then added under atmospheric pressure with stirring at 118°-130°C. After 5.6 hrs., a total of 917 g. (20.84 moles) of EO had been added to give a calculated total degree of ethoxylation of 12.58. The ethoxylated amine obtained was a dark amber mobile liquid.

25

Example 5

By a procedure similar to that of Example 1, sieve dried (3A) ethylenediamine (M.W. 60, 42 g., 0.7 moles) was placed in a nominally dry flask, and hydroxyethylated at 25°-116°C with rapid stirring. After 3.3 hrs., 143.3 g. (3.25 moles) of EO had been added for a degree of ethoxylation of 1.16. After cooling the reaction mixture under argon, 9.82 g. (0.07 moles) of freshly prepared 40% potassium hydroxide solution was added. Water was removed by stirring at 110°-115°C for 0.5 hours with an aspirator vacuum and 0.5 hours with a pump vacuum. EO was then added under

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atmospheric pressure with stirring at 100°-138°C. After 6 hrs. a total of 2935 g. (66.7 moles) of EO had been added to give a calculated total degree of ethoxylation of 23.82. The ethoxylated diamine obtained was a brown waxy solid when cooled.

5

Detergent Surfactants

The amount of detergent surfactant included in the detergent compositions of the present invention can vary from about 1 to about 75% by weight of the composition depending upon the detergent surfactant(s) used, the type of composition to be formulated (e.g. granular, liquid) and the effects desired. Preferably, the detergent surfactant(s) comprises from about 10 to about 50% by weight of the composition. The detergent surfactant can be nonionic, anionic, ampholytic, zwitterionic, cationic, or a mixture thereof:

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A. Nonionic Surfactants

Suitable nonionic surfactants for use in detergent compositions of the present invention are generally disclosed in U.S. Patent 3,929,678 to Laughlin et al., issued December 30, 1975 at column 13, line 14 through column 16, line 6 (herein incorporated by reference). Classes of nonionic surfactants included are:

20

1. The polyethyleneoxide condensates of alkyl phenols.

These compounds include the condensation products of alkyl phenols having an alkyl group containing from about 6 to 12 carbon atoms in either a straight chain or branched chain configuration with ethylene oxide, the ethylene oxide being present in an amount equal to 5 to 25 moles of ethylene oxide per mole of alkyl phenol. The alkyl substituent in such compounds can be derived, for example, from polymerized propylene, diisobutylene, and the like. Examples of compounds of this type include nonyl phenol condensed with about 9.5 moles of ethylene oxide per mole of nonyl phenol; dodecylphenol condensed with about 12 moles of ethylene oxide per mole of phenol; dinonyl phenol condensed with about 15 moles of ethylene oxide per mole of phenol; and diisooctyl phenol condensed with about 15 moles of ethylene oxide per mole of phenol. Commercially available nonionic surfactants of this type include Igepal

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CO-630, marketed by the GAF Corporation, and Triton X-45, X-114, X-100, and X-102, all marketed by the Rohm & Haas Company.

2. The condensation products of aliphatic alcohols with from about 1 to about 25 moles of ethylene oxide. The alkyl chain of the aliphatic alcohol can either be straight or branched, primary or secondary, and generally contains from about 8 to about 22 carbon atoms. Examples of such ethoxylated alcohols include the condensation product of myristyl alcohol condensed with about 10 moles of ethylene oxide per mole of alcohol; and the condensation product of about 9 moles of ethylene oxide with coconut alcohol (a mixture of fatty alcohols with alkyl chains varying in length from 10 to 14 carbon atoms). Examples of commercially available nonionic surfactants of this type include Tergitol 15-S-9, marketed by Union Carbide Corporation, Neodol 45-9, Neodol 23-6.5, Neodol 45-7, and Neodol 45-4, marketed by Shell Chemical Company, and Kyro EOB, marketed by The Procter & Gamble Company.

3. The condensation products of ethylene oxide with a hydrophobic base formed by the condensation of propylene oxide with propylene glycol. The hydrophobic portion of these compounds has a molecular weight of from about 1500 to 1800 and exhibits water insolubility. The addition of polyoxyethylene moieties to this hydrophobic portion tends to increase the water solubility of the molecule as a whole, and the liquid character of the product is retained up to the point where the polyoxyethylene content is about 50% of the total weight of the condensation product, which corresponds to condensation with up to about 40 moles of ethylene oxide. Examples of compounds of this type include certain of the commercially available Pluronic surfactants, marketed by Wyandotte Chemical Corporation.

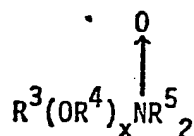
4. The condensation products of ethylene oxide with the product resulting from the reaction of propylene oxide and ethylenediamine. The hydrophobic moiety of these products consists of the reaction product of ethylenediamine and excess propylene oxide, the moiety having a molecular weight of from about 2500 to about 3000. This hydrophobic moiety is condensed with ethylene oxide to the extent that the condensation product contains from

about 40% to about 80% by weight of polyoxyethylene and has a molecular weight of from about 5,000 to about 11,000. Examples of this type of nonionic surfactant include certain of the commercially available Tetronic compounds, marketed by Wyandotte Chemical Corporation.

5 5. Semi-polar nonionic detergent surfactants which include water-soluble amine oxides containing one alkyl moiety of from about 10 to 18 carbon atoms and 2 moieties selected from the group consisting of alkyl groups and hydroxyalkyl groups containing from
10 1 to about 3 carbon atoms; water-soluble phosphine oxides containing one alkyl moiety of from about 10 to 18 carbon atoms and 2 moieties selected from the group consisting of alkyl groups and hydroxyalkyl groups containing from about 1 to 3 carbon atoms; and
15 water-soluble sulfoxides containing one alkyl moiety of from about 10 to 18 carbon atoms and a moiety selected from the group consisting of alkyl and hydroxyalkyl moieties of from about 1 to 3 carbon atoms.

Preferred semi-polar nonionic detergent surfactants are the amine oxide detergent surfactants having the formula

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25 wherein R^3 is an alkyl, hydroxyalkyl, or alkyl phenyl group or mixtures thereof containing from about 8 to about 22 carbon atoms; R^4 is an alkylene or hydroxyalkylene group containing from 2 to 3 carbon atoms or mixtures thereof; x is from 0 to about 3; and each R^5 is an alkyl or hydroxyalkyl group containing from 1 to about 3
30 carbon atoms or a polyethylene oxide group containing from one to about 3 ethylene oxide groups. The R^5 groups can be attached to each other, e.g., through an oxygen or nitrogen atom to form a ring structure.

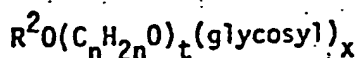
Preferred amine oxide detergent surfactants are $\text{C}_{10}\text{-C}_{18}$ alkyl
35 dimethyl amine oxide and $\text{C}_8\text{-C}_{12}$ alkoxy ethyl dihydroxy ethyl amine oxide.

6. Alkylpolysaccharides disclosed in European Patent Application 82200868.6, R.A. Llenado, filed on July 12, 1982, having a hydrophobic group containing from about 6 to about 30 carbon atoms, preferably from about 10 to about 16 carbon atoms and a polysaccharide, e.g., a polyglycoside, hydrophilic group containing from about 1½ to about 10, preferably from about 1½ to about 3, most preferably from about 1.6 to about 2.7 saccharide units. Any reducing saccharide containing 5 or 6 carbon atoms can be used, e.g. glucose, galactose and galactosyl moieties can be substituted for the glucosyl moieties. (Optionally the hydrophobic group is attached at the 2, 3, 4, etc. positions thus giving a glucose or galactose as opposed to a glucoside or galactoside.) The intersaccharide bonds can be, e.g., between the one position of the additional saccharide units and the 2-, 3-, 4-, and/or 6 positions on the preceding saccharide units.

Optionally, and less desirably, there can be a polyalkyleneoxide chain joining the hydrophobic moiety and the polysaccharide moiety. The preferred alkyleneoxide is ethylene oxide. Typical hydrophobic groups include alkyl groups, either saturated or unsaturated, branched or unbranched containing from about 8 to about 18, preferably from about 10 to about 16, carbon atoms. Preferably, the alkyl group is a straight chain saturated alkyl group. The alkyl group can contain up to 3 hydroxy groups and/or the polyalkyleneoxide chain can contain up to about 10, preferably less than 5, most preferably 0, alkyleneoxide moieties. Suitable alkyl polysaccharides are octyl, nonyldecyl, undecyldodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, and octadecyl, di-, tri-, tetra-, penta-, and hexagluco-
sides, lactosides, glucoses, fructosides, fructoses, and/or galactoses. Suitable mixtures include coconut alkyl, di-, tri-, tetra-, and pentagluco-
sides and tallow alkyl tetra-, penta-, and hexagluco-
sides.

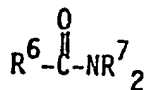
The preferred alkylpolyglycosides have the formula

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wherein R^2 is selected from the group consisting of alkyl, alkyl-phenyl, hydroxyalkyl, hydroxyalkylphenyl, and mixtures thereof in which the alkyl groups contain from about 10 to about 18, preferably from about 12 to about 14, carbon atoms; n is 2 or 3, preferably 2; t is from 0 to about 10, preferably 0; and x is from $1\frac{1}{2}$ to about 10, preferably from about $1\frac{1}{2}$ to about 3, most preferably from about 1.6 to about 2.7. The glycosyl is preferably derived from glucose. To prepare these compounds, the alcohol or alkyl-polyethoxy alcohol is formed first and then reacted with glucose, or a source of glucose, to form the glucoside (attachment at the 1-position). The additional glycosyl units can then be attached between their 1-position and the preceding glycosyl units 2-, 3-, 4- and/or 6- position, preferably predominately the 2-position.

7. Fatty acid amide detergent surfactants having the formula:



wherein R^6 is an alkyl group containing from about 7 to about 21 (preferably from about 9 to about 17) carbon atoms and each R^7 is selected from the group consisting of hydrogen, C_1 - C_4 alkyl, C_1 - C_4 hydroxyalkyl, and $-(C_2H_4O)_xH$ where x varies from about 1 to about 3.

Preferred amides are C_8 - C_{20} ammonia amides, monoethanol-amides, diethanolamides, and isopropanol amides.

B. Anionic Surfactants

Anionic surfactants suitable in detergent compositions of the present invention are generally disclosed in U.S. Patent 3,929,678 to Laughlin et al., issued December 30, 1975 at column 23, line 58 through column 29, line 23 (herein incorporated by reference). Classes of anionic surfactants included are:

1. Ordinary alkali metal soaps such as the sodium, potassium, ammonium and alkylolammonium salts of higher fatty acids containing from about 8 to about 24 carbon atoms, preferably from about 10 to about 20 carbon atoms.

2. Water-soluble salts, preferably the alkali metal, ammonium and alkylammonium salts, of organic sulfuric reaction products having in their molecular structure an alkyl group containing from about 10 to about 20 carbon atoms and a sulfonic acid or sulfuric acid ester group. (Included in the term "alkyl" is the alkyl portion of acyl groups.)

Examples of this group of anionic surfactants are the sodium and potassium alkyl sulfates, especially those obtained by sulfating the higher alcohols (C_8 - C_{18} carbon atoms) such as those produced by reducing the glycerides of tallow or coconut oil; and the sodium and potassium alkylbenzene sulfonates in which the alkyl group contains from about 9 to about 15 carbon atoms, in straight chain or branched chain configuration, e.g., those of the type described in U.S. Patents 2,220,099 and 2,477,383. Especially valuable are linear straight chain alkylbenzene sulfonates in which the average number of carbon atoms in the alkyl group is from about 11 to 13, abbreviated as C_{11} - C_{13} LAS.

Preferred anionic surfactants of this type are the alkyl polyethoxylate sulfates, particularly those in which the alkyl group contains from about 10 to about 22, preferably from about 12 to about 18 carbon atoms, and wherein the polyethoxylate chain contains from about 1 to about 15 ethoxylate moieties preferably from about 1 to about 3 ethoxylate moieties. These anionic detergent surfactants are particularly desirable for formulating heavy-duty liquid laundry detergent compositions.

Other anionic surfactants of this type include sodium alkyl glyceryl ether sulfonates, especially those ethers of higher alcohols derived from tallow and coconut oil; sodium coconut oil fatty acid monoglyceride sulfonates and sulfates; sodium or potassium salts of alkyl phenol ethylene oxide ether sulfates containing from about 1 to about 10 units of ethylene oxide per molecule and wherein the alkyl groups contain from about 8 to about 12 carbon atoms; and sodium or potassium salts of alkyl ethylene oxide ether sulfates containing about 1 to about 10 units of ethylene oxide per molecule and wherein the alkyl group contains from about 10 to about 20 carbon atoms.

Also included are water-soluble salts of esters of alpha-sulfonated fatty acids containing from about 6 to 20 carbon atoms in the fatty acid group and from about 1 to 10 carbon atoms in the ester group; water-soluble salts of 2-acyloxy-alkane-1-sulfonic acids containing from about 2 to 9 carbon atoms in the acyl group and from about 9 to about 23 carbon atoms in the alkane moiety; alkyl ether sulfates containing from about 10 to 20 carbon atoms in the alkyl group and from about 1 to 30 moles of ethylene oxide; water-soluble salts of olefin sulfonates containing from about 12 to 24 carbon atoms; and beta-alkyloxy alkane sulfonates containing from about 1 to 3 carbon atoms in the alkyl group and from about 8 to 20 carbon atoms in the alkane moiety.

3. Anionic phosphate surfactants.

4. N-alkyl substituted succinamates.

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C. Ampholytic Surfactants

Ampholytic surfactants can be broadly described as aliphatic derivatives of secondary or tertiary amines, or aliphatic derivatives of heterocyclic secondary and tertiary amines in which the aliphatic radical can be straight chain or branched and wherein one of the aliphatic substituents contains from about 8 to 18 carbon atoms and at least one contains an anionic water-solubilizing group, e.g. carboxy, sulfonate, sulfate. See U.S. Patent 3,929,678 to Laughlin et al., issued December 30, 1975 at column 19, lines 18-35 (herein incorporated by reference) for examples of ampholytic surfactants.

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D. Zwitterionic Surfactants

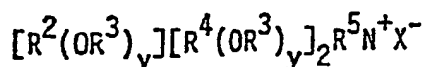
Zwitterionic surfactants can be broadly described as derivatives of secondary and tertiary amines, derivatives of heterocyclic secondary and tertiary amines, or derivatives of quaternary ammonium, quaternary phosphonium or tertiary sulfonium compounds. See U.S. Patent 3,929,678 to Laughlin et al., issued December 30, 1975 at column 19, line 38 through column 22, line 48 (herein incorporated by reference) for examples of zwitterionic surfactants.

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E. Cationic Surfactants

Cationic surfactants can also be included in detergent compositions of the present invention. Suitable cationic surfactants include the quaternary ammonium surfactants having the formula:



wherein R^2 is an alkyl or alkyl benzyl group having from about 8 to about 18 carbon atoms in the alkyl chain; each R^3 is selected from the group consisting of $-CH_2CH_2-$, $-CH_2CH(CH_3)-$, $-CH_2CH(CH_2OH)-$, $-CH_2CH_2CH_2-$, and mixtures thereof; each R^4 is selected from the group consisting of C_1 - C_4 alkyl, C_1 - C_4 hydroxyalkyl, benzyl, ring structures formed by joining the two R^4 groups, $-CH_2CHOHCHOHCO R^6CHOHCH_2OH$ wherein R^6 is any hexose or hexose polymer having a molecular weight less than about 1000, and hydrogen when y is not 0; R^5 is the same as R^4 or is an alkyl chain wherein the total number of carbon atoms of R^2 plus R^5 is not more than about 18; each y is from 0 to about 10 and the sum of the y values is from 0 to about 15; and X is any compatible anion.

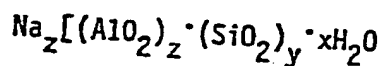
Preferred of the above are the alkyl quaternary ammonium surfactants, especially the mono-long chain alkyl surfactants described in the above formula when R^5 is selected from the same groups as R^4 . The most preferred quaternary ammonium surfactants are the chloride, bromide and methylsulfate C_8 - C_{16} alkyl trimethylammonium salts, C_8 - C_{16} alkyl di(hydroxyethyl)methylammonium salts, the C_8 - C_{16} alkyl hydroxyethyldimethylammonium salts, and C_8 - C_{16} alkyloxypropyl trimethylammonium salts. Of the above, decyl trimethylammonium methylsulfate, lauryl trimethylammonium chloride, myristyl trimethylammonium bromide and coconut trimethylammonium chloride and methylsulfate are particularly preferred.

Detergent Builders

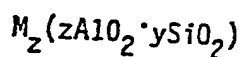
Detergent compositions of the present invention can optional-

ly comprise inorganic or organic detergent builders to assist in mineral hardness control. These builders can comprise from 0 to about 80% by weight of the composition. When included, these builders typically comprise up to about 60% by weight of the detergent composition. Built liquid formulations preferably comprise from about 10 to about 25% detergent builder while built granular formulations preferably comprise from about 10 to about 50% by weight detergent builder.

Suitable detergent builders include crystalline aluminosilicate ion exchange materials having the formula:



wherein z and y are at least about 6, the mole ratio of z to y is from about 1.0 to about 0.5; and x is from about 10 to about 264. Amorphous hydrated aluminosilicate materials useful herein have the empirical formula



wherein M is sodium, potassium, ammonium or substituted ammonium, z is from about 0.5 to about 2; and y is 1; this material having a magnesium ion exchange capacity of at least about 50 milligram equivalents of CaCO_3 hardness per gram of anhydrous aluminosilicate.

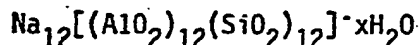
The aluminosilicate ion exchange builder materials are in hydrated form and contain from about 10% to about 28% of water by weight if crystalline, and potentially even higher amounts of water if amorphous. Highly preferred crystalline aluminosilicate ion exchange materials contain from about 18% to about 22% water in their crystal matrix. The preferred crystalline aluminosilicate ion exchange materials are further characterized by a particle size diameter of from about 0.1 micron to about 10 microns. Amorphous materials are often smaller, e.g., down to less than about 0.01 micron. More preferred ion exchange materials have a

particle size diameter of from about 0.2 micron to about 4 microns. The term "particle size diameter" represents the average particle size diameter of a given ion exchange material as determined by conventional analytical techniques such as, for example, microscopic determination utilizing a scanning electron microscope. The crystalline aluminosilicate ion exchange materials are usually further characterized by their calcium ion exchange capacity, which is at least about 200 mg. equivalent of CaCO_3 water hardness/g. of aluminosilicate, calculated on an anhydrous basis, and which generally is in the range of from about 300 mg. eq./g. to about 352 mg. eq./g. The aluminosilicate ion exchange materials are still further characterized by their calcium ion exchange rate which is at least about 2 grains Ca^{++} /gallon/minute/gram/gallon of aluminosilicate (anhydrous basis), and generally lies within the range of from about 2 grains/gallon/minute/gram/gallon to about 6 grains/gallon/minute/gram/gallon, based on calcium ion hardness. Optimum aluminosilicates for builder purposes exhibit a calcium ion exchange rate of at least about 4 grains/gallon/minute/gram/gallon.

The amorphous aluminosilicate ion exchange materials usually have a Mg^{++} exchange capacity of at least about 50 mg. eq. CaCO_3 /g. (12 mg. Mg^{++} /g.) and a Mg^{++} exchange rate of at least about 1 grain/gallon/minute/gram/gallon. Amorphous materials do not exhibit an observable diffraction pattern when examined by Cu radiation (1.54 Angstrom Units).

Useful aluminosilicate ion exchange materials are commercially available. These aluminosilicates can be crystalline or amorphous in structure and can be naturally-occurring aluminosilicates or synthetically derived. A method for producing aluminosilicate ion exchange materials is disclosed in U.S. Patent 3,985,669 to Krummel, et al. issued October 12, 1976 (herein incorporated by reference). Preferred synthetic crystalline aluminosilicate ion exchange materials useful herein are available under the designations Zeolite A, Zeolite P (B), and ~~Zeolite X.~~

In an especially preferred embodiment, the crystalline aluminosilicate ion exchange material has the formula



wherein x is from about 20 to about 30, especially about 27.

Other examples of detergency builders include the various
5 water-soluble, alkali metal, ammonium or substituted ammonium
phosphates, polyphosphates, phosphonates, polyphosphonates,
carbonates, silicates, borates, polyhydroxysulfonates, polyace-
tates, carboxylates, and polycarboxylates. Preferred are the
alkali metal, especially sodium, salts of the above.

10 Specific examples of inorganic phosphate builders are sodium
and potassium tripolyphosphate, pyrophosphate, polymeric metaphate
having a degree of polymerization of from about 6 to 21, and
orthophosphate. Examples of polyphosphonate builders are the
sodium and potassium salts of ethylene-1,1-diphosphonic acid, the
15 sodium and potassium salts of ethane 1-hydroxy-1,1-diphosphonic
acid and the sodium and potassium salts of ethane, 1,1,2-triphos-
phonic acid. Other phosphorus builder compounds are disclosed in
U.S. Patents 3,159,581; 3,213,030; 3,422,021; 3,422,137; 3,400,176
and 3,400,148 (all herein incorporated by reference).

20 Examples of nonphosphorus, inorganic builders are sodium and
potassium carbonate, bicarbonate, sesquicarbonate, tetraborate
decahydrate, and silicate having a mole ratio of SiO_2 to alkali
metal oxide of from about 0.5 to about 4.0, preferably from about
1.0 to about 2.4.

25 Useful water-soluble, nonphosphorus organic builders include
the various alkali metal, ammonium and substituted ammonium
polyacetates, carboxylates, polycarboxylates and polyhydroxy-
sulfonates. Examples of polyacetate and polycarboxylate builders
are the sodium, potassium lithium, ammonium and substituted
30 ammonium salts of ethylenediamine tetraacetic acid, nitrilotri-
acetic acid, oxydisuccinic acid, mellitic acid, benzene polycar-
boxylic acids, and citric acid.

Highly preferred polycarboxylate builders are disclosed in
U.S. Patent No. 3,308,067 to Diehl, issued March 7, 1967 (herein
35 incorporated by reference). Such materials include the water-
soluble salts of homo- and copolymers of aliphatic carboxylic

acids such as maleic acid, itaconic acid, mesaconic acid, fumaric acid, aconitic acid, citraconic acid and methylenemalononic acid.

Other builders include the carboxylated carbohydrates disclosed in U.S. Patent 3,723,322 to Diehl issued March 28, 1973 (herein incorporated by reference).

Other useful builders are sodium and potassium carboxymethyloxymalonate, carboxymethyloxysuccinate, cis-cyclohexanehexacarboxylate, cis-cyclopentanetetra-carboxylate phloroglucinol trisulfonate, water-soluble polyacrylates (having molecular weights of from about 2,000 to about 200,000 for example), and the copolymers of maleic anhydride with vinyl methyl ether or ethylene.

Other suitable polycarboxylates are the polyacetal carboxylates disclosed in U.S. Patent 4,144,226, to Crutchfield et al. issued March 13, 1979, and U.S. Patent 4,246,495, to Crutchfield et al., issued March 27, 1979 (both herein incorporated by reference). These polyacetal carboxylates can be prepared by bringing together under polymerization conditions an ester of glyoxylic acid and a polymerization initiator. The resulting polyacetal carboxylate ester is then attached to chemically stable end groups to stabilize the polyacetal carboxylate against rapid depolymerization in alkaline solution, converted to the corresponding salt, and added to a surfactant.

Other useful detergency builder materials are the "seeded builder" compositions disclosed in Belgian Patent No. 798,856, issued October 29, 1973, (herein incorporated by reference). Specific examples of such seeded builder mixtures are: 3:1 wt. mixtures of sodium carbonate and calcium carbonate having 5 micron particle diameter; 2.7:1 wt. mixtures of sodium sesquicarbonate and calcium carbonate having a particle diameter of 0.5 microns; 20:1 wt. mixtures of sodium sesquicarbonate and calcium hydroxide having a particle diameter of 0.01 micron; and a 3:3:1 wt. mixture of sodium carbonate, sodium aluminate and calcium oxide having a particle diameter of 5 microns.

35

Other Optional Detergent Ingredients

Other optional ingredients which can be included in detergent

compositions of the present invention, in their conventional art-established levels for use (i.e., from 0 to about 20%), include solvents, bleaching agents, bleach activators, soil-suspending agents, corrosion inhibitors, dyes, fillers, optical brighteners, germicides, pH adjusting agents (monoethanolamine, sodium carbonate, sodium hydroxide, etc.), enzymes, enzyme-stabilizing agents, perfumes, fabric softening components, static control agents, and the like.

10

Detergent Formulations

Granular formulations embodying the detergent compositions of the present invention can be formed by conventional techniques, i.e., by slurring the individual components in water and then atomizing and spray-drying the resultant mixture, or by pan or drum granulation of the ingredients. Granular formulations preferably comprise from about 10 to about 30% detergent surfactant, usually anionic.

Liquid formulations embodying the detergent compositions can be built or unbuilt. If unbuilt, these compositions conventionally contain approximately 15 to 50% total surfactant, from 0 to 10% of an organic base such as a mono-, di-, or tri-alkanol amine, a neutralization system such as an alkali metal hydroxide and a lower primary alcohol such as ethanol or isopropanol, and approximately 20 to 80% water. Such compositions are normally homogeneous single phase liquids of low viscosity (approximately 100 to 150 centipoise at 75°F).

Built liquid detergent compositions can be in the form of single phase liquids provided that the builder is solubilized in the mixture at its level of use. Such liquids conventionally contain 10 to 25% total surfactant, 10 to 25% builder which can be organic or inorganic, 3 to 10% of a hydrotrope system and 40 to 77% water. Liquids of this type also have a low viscosity (100 to 150 centipoise at 75°F). Built liquid detergents incorporating components that form heterogeneous mixtures (or levels of builder that cannot be completely dissolved) can also comprise detergent

compositions of the present invention. Such liquids conventionally employ viscosity modifiers to produce systems having plastic shear characteristics to maintain stable dispersions and to prevent phase separation or solid settlement.

5

Near Neutral Wash pH Detergent Formulations

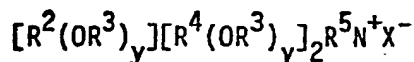
While the detergent compositions of the present invention are operative within a wide range of wash pHs (e.g. from about 5 to about 12), they are particularly suitable when formulated to provide a near neutral wash pH, i.e. an initial pH of from about 6.0 to about 8.5 at a concentration of from about 0.1 to about 2% by weight in water at 20°C. Near neutral wash pH formulations are better for enzyme stability and for preventing stains from setting. In such formulations, the wash pH is preferably from about 7.0 to about 8.5, and more preferably from about 7.5 to about 8.0.

Preferred near neutral wash pH detergent formulations are disclosed in European Patent Application 83200688.6, J.H.M. Wertz and P.C.E. Goffinet, filed on May 16, 1983. These preferred formulations comprise:

(a) from about 2 to about 60% (preferably from about 10 to about 25%) by weight of an anionic synthetic surfactant as previously defined;

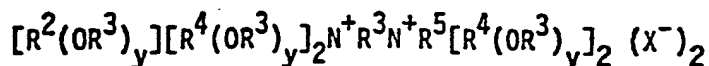
(b) from about 0.25 to about 12% (preferably from about 1 to about 4%) by weight of a cosurfactant selected from the group consisting of:

(i) quaternary ammonium surfactants having the formula:



wherein R^2 , each R^3 , R^4 , R^5 , X and y are as previously defined; each y is from 0 to about 10 and the sum of the y values is from 0 to about 15; and X is any compatible anion;

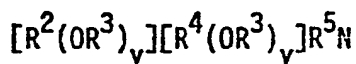
(ii) diquaternary ammonium surfactants having the formula:



wherein R^2 , R^3 , R^4 , y and X are as defined above; particularly preferred are the C_8 - C_{16} alkyl pentamethylethylene-diamine chloride, bromide and methylsulfate salts;

(iii) amine surfactants having the formula:

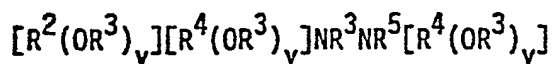
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wherein R^2 , R^3 , R^4 , R^5 and y are as defined above; particularly preferred are the C_{12} - C_{16} alkyl dimethyl amines;

10

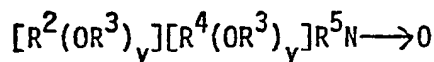
(iv) diamine surfactants having the formula:



15

wherein R^2 , R^3 , R^4 , R^5 and y are as defined above; particularly preferred are the C_{12} - C_{16} alkyl dimethyl diamines;

(v) amine oxide surfactants having the formula:

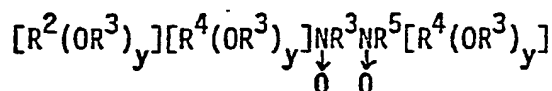


20

wherein R^2 , R^3 , R^4 , R^5 and y are as defined above; particularly preferred are the C_{12} - C_{16} alkyldimethyl amine oxides; and

(vi) di(amine oxide) surfactants having the formula:

25



30

wherein R^2 , R^3 , R^4 , R^5 and y are as defined above; preferred are the C_{12} - C_{16} alkyl trimethylethylene di(amine oxides) and

(c) from about 5% to about 40% by weight (preferably 7 to about 30% by weight, and most preferably from about 10 to 20% by weight) of a fatty acid containing from about 10 to about 22 carbon atoms (preferably a C_{10} - C_{14} saturated fatty acid or mixture thereof); the mole ratio of the anionic surfactant to the cosurfactant being at least 1 and preferably from about 2:1 to about 20:1.

Such compositions also preferably contain from about 3 to about 15% by weight of an ethoxylated alcohol or ethoxylated alkyl phenol (nonionic surfactants) as previously defined. Highly preferred compositions of this type also preferably contain from
 5 about 2 to about 10% by weight of citric acid and minor amounts (e.g., less than about 20% by weight) of neutralizing agents, buffering agents, phase regulants, hydrotropes, enzymes, enzyme stabilizing agents, polyacids, suds regulants, opacifiers, anti-oxidants, bactericides, dyes, perfumes and brighteners, such as
 10 those described in U.S. Patent 4,285,841 to Barrat et al., issued August 25, 1981 (herein incorporated by reference).

Clay Soil Removal/Anti-Redeposition Properties of
Various Ethoxylated Amines

15 A. Experimental Method

1. Clay Soil Removal

Clay soil removal comparisons were conducted in a standard 1 liter Tergotometer employing water of 7 grain hardness (3:1 $\text{Ca}^{++}:\text{Mg}^{++}$) and a temperature of 100°F. Soiled swatches were
 20 washed in the Tergotometer for 10 minutes and rinsed twice with water (7 grain hardness) at 70°F for 2 minutes.

65% polyester/35% cotton blend fabric was used for the swatches. The swatches were 5 inches by 5 inches in size and were soiled by dipping in an aqueous slurry of local clay and subse-
 25 quently baked to remove the water. The dipping and baking was repeated 5 times.

One wash employed 2000 ppm of a control liquid detergent composition containing the following surfactants:

<u>Surfactant</u>	<u>Amount (%)</u>
30 Sodium $\text{C}_{14}\text{-C}_{15}$ alkyl ethoxysulfate	10.8
C_{13} linear alkylbenzene sulfonic acid	7.2
$\text{C}_{12}\text{-C}_{13}$ alcohol poly- 35 ethoxylate (6.5)	6.5
C_{12} alkyl trimethyl-	

ammonium chloride 1.2

A second wash used the same detergent composition but also containing an ethoxylated amine at 20 ppm. Neither composition
5 contained optical brighteners. The product washes approximated a conventional home use laundry situation. After laundering, the swatches were dried in a mini-dryer.

The swatches were graded before and after washing on a Gardner Whiteness meter reading the L, a, and b coordinates.
10 Whiteness (W) was calculated as:

$$W = \frac{7L^2 - 40Lb}{700}$$

The clay soil removal performance of each detergent composition was determined by finding the difference in whiteness (W) before
15 and after washing as:

$$\Delta W = W_{\text{after}} - W_{\text{before}}$$

The improvement in clay soil removal performance of the composition containing the ethoxylated amine was measured as the difference in W values ($\Delta^2 W$) relative to the control composition.
20

2. Anti-Redeposition

Anti-redeposition comparisons were conducted in a 5 pot
25 Automatic Miniwasher (AMW) employing 7 grain hardness water and temperature of 95°F. Test swatches were washed for 10 minutes and rinsed twice with water (7 grain hardness) at 75°F for 2 minutes.

After the AMW pots were filled with 6 liters of water each, the detergent composition to be tested (control or containing 20
30 ppm ethoxylated amine as in clay soil removal test) was added and agitated for 2 minutes. A background soil mixture (200 ppm artificial body soil, 100 ppm vacuum cleaner soil and 200 ppm clay soil) was then added and agitated for an additional 3 minutes. Three 5 inch square test swatches (50% polyester/50% cotton
35 T-shirt material) were then added, along with two 80% cotton/20% polyester terry clothes and two 11 inch square swatches of 100%

polyester knit fabric. The 10 minute wash cycle commenced at this point.

Following the rinse cycle, the test swatches were dried in a mini-dryer. Gardner Whiteness meter readings (L, a and b) were then determined for the three test swatches. Anti-redeposition performance (ARD) was then calculated according to the following equation:

$$ARD = \frac{7L^2 - 40Lb}{700}$$

10

The ARD values for the three test swatches were then averaged. The improvement in anti-redeposition performance of the composition containing the ethoxylated amine was measured as the difference in ARD values (Δ ARD) relative to the control composition.

15

B. Test Results

The results from testing the clay-soil removal and anti-redeposition performance of various ethoxylated amines is shown in the following Table:

Amine *	Amine	Degree of		
<u>Type</u>	<u>M.W.</u>	<u>Ethoxylation</u>	<u>Δ ²W</u>	<u>Δ ARD</u>
20	TEA	17	5	1.6
			12	4.6
			17	7.4
			26	7.6
25			35	7.4
				-
				-
30	EDA	60	3	1.7
			8	2.9
			12	5.1
			24	6.1
			42	5.5
35	PDA	74	3	2.4
			6	2.4
			13	6.1
				3.2
				6.2
				10.7

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			24	5.8	11.4
			43	5.4	12.4
	HMDA		3	-	13.3
5			6	-	16.4
	PEA	103	3	2.4	5.1
			6	4.0	10.0
			12	6.5	-
10			24	7.7	17.4
	PEA	189	3	5.0	10.6
			12	5.1	14.8
			15	10.8	16.4
15			18	7.3	17.2
			22	8.6	17.3
			37	8.5	16.3
			80	6.3	16.1
20	PEA	309	2	-2.4	-
			12	6.1	-
			18	9.1	-
			24	8.7	20.7
25	PEI	600	3	0.6	17.9
			12	5.6	20.5
			24	6.0	20.9
			42	7.7	20.5
30	PEI	1800	5	1.6	14.4
			13	3.1	17.7
			29	5.5	16.6
	PPI	20,000	6	0.6	5.0
35			24	-1.3	11.6
			42	-	13.8

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*TEA = triethanolamine, EDA = ethylenediamine, PDA = propylene-diamine, HMDA = hexamethylenediamine, PEA = polyethyleneamine, PEI = polyethyleneimine, PPI = polypropyleneimine

5 For comparison, PEG 6000 (polyethylene glycol having M.W. of 6000) has a Δ^2W value of 4.9 and a ΔARD value of 8.9.

Specific Embodiments of Detergent Compositions

According to the Present Invention

10 Embodiment I

The following embodiments illustrate, but are not limiting of, detergent compositions of the present invention:

A granular detergent composition is as follows:

	<u>Component</u>	<u>Wt. %</u>
15	PEI ₆₀₀ E ₂₄ *	1.0
	Sodium C ₁₄ -C ₁₅ alkylethoxysulfate	10.7
	C ₁₃ linear alkyl benzene sulfonic acid	4.3
	C ₁₂ -C ₁₄ alkylpolyethoxylate (6)	0.5
	Sodium toluene sulfonate	1.0
20	Sodium tripolyphosphate	32.9
	Sodium carbonate	20.3
	Sodium silicate	5.8
	Minors and water	Balance to 100

25 * PEI having M.W. of 600 and degree of ethoxylation of 24.

The components are added together with continuous mixing to form an aqueous slurry which is then spray dried to form the composition.

30

35

Embodiment II

A liquid detergent composition is as follows:

<u>Component</u>		<u>Wt. %</u>
	PEA ₁₈₉ E ₁₇ *	1.0
5	Sodium C ₁₄ -C ₁₅ alkyl polyethoxy (2.5) sulfate	8.3
	C ₁₂ -C ₁₄ alkyl dimethyl amine oxide	3.3
	Sodium toluene sulfonate	5.0
	Monoethanolamine	2.3
	Sodium nitrilotriacetate	18.2
10	Minors and water	Balance to 100

* PEA having M.W. of 189 and degree of ethoxylation of 17.

The components are added together with continuous mixing to form the composition.

15

Embodiments III and IV

Liquid detergent compositions are as follows:

<u>Component</u>		<u>Wt. %</u>	
		<u>III</u>	<u>IV</u>
20	PEA ₁₈₉ E ₁₇	1.5	1.5
	C ₁₄ -C ₁₅ alkylethoxysulfuric acid	10.8	-
	C ₁₄ -C ₁₅ alkylpolyethoxy (2.25) sulfuric acid	-	10.8
	C ₁₃ linear alkylbenzene sulfonic acid	7.2	7.2
	C ₁₂ alkyl trimethylammonium chloride	1.2	1.2
25	C ₁₂ -13 alcohol polyethoxylate (6.5)	6.5	6.5
	Coconut fatty acid	15.0	15.0
	Citric acid monohydrate	6.9	4.0
	Diethylenetriamine pentaacetic acid	0.9	0.9
	Protease enzyme	0.8	0.8
30	Amylase enzyme	0.3	0.3
	Monoethanolamine	13.6	2.0
	Triethanolamine	3.0	4.0
	Sodium hydroxide	-	2.0
	Potassium hydroxide	-	2.8
35	1,2-Propanediol	5.0	5.0
	Ethanol	3.0	7.0

Sodium formate	1.0	1.0
Sodium toluene sulfonate	5.0	-
Minors and water	Balance to 100	

- 5 Embodiment IV is prepared by adding the components together with continuous mixing, in the following order to produce a clear liquid: a paste premix of the alkylbenzene sulfonic acid, 0.9 parts of the sodium hydroxide, propylene glycol, and 2.3 parts of the ethanol; a paste premix of the alkylpolyethoxysulfuric acid,
- 10 1.1 parts of the sodium hydroxide and 3.1 parts of the ethanol; alcohol polyethoxylate; premix of monoethanolamine, triethanolamine and brighteners; 1.5 parts potassium hydroxide; balance of the ethanol; citric acid; formate; 1.4 parts potassium hydroxide; fatty acid; pentaacetic acid; alkyl trimethylammonium chloride;
- 15 adjust pH to about 8.4 with potassium hydroxide, water or citric acid; enzymes; PEA_{189E17} (50% aqueous solution); and perfume. Embodiment III can be prepared in a similar manner.

Embodiment V

- 20 A liquid detergent composition is formulated as follows:

<u>Component</u>	<u>Wt. %</u>
PEA _{189E17}	1.0
Sodium C ₁₂ alkylpolyethoxy (3) sulfate	12.6
C ₁₂ -C ₁₃ alcohol polyethoxylate (6.5)	23.4
25 Monoethanolamine	2.0
Ethanol	9.0
Citric acid monohydrate	0.8
Minors and water	Balance to 100

- 30 The components are added together with continuous mixing to form the composition.

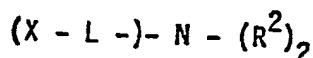
CLAIMS

1. A detergent composition, which comprises:

(a) from about 1 to about 75% by weight of a detergent surfactant selected from the group consisting of nonionic, anionic, ampholytic, zwitterionic or cationic detergent surfactants or mixtures thereof; and

(b) from about 0.05 to about 95% by weight of a water-soluble ethoxylated amine having clay soil removal/anti-redeposition properties selected from the group consisting of

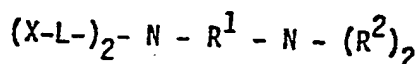
(1) ethoxylated monoamines having the formula:



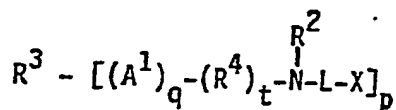
(2) ethoxylated diamines having the formula:



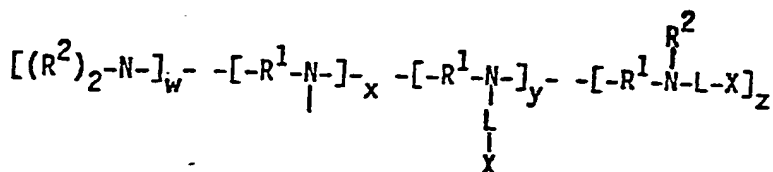
or



(3) ethoxylated polyamines having the formula:



(4) ethoxylated amine polymers having the general formula:



(12)

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(54) **Detergent compositions containing ethoxylated amines having clay soil removal/anti-redeposition properties.**

(57) Water-soluble ethoxylated amine compounds having clay soil removal/anti-redeposition properties. The compounds are selected from ethoxylated diamine compounds, ethoxylated polyamines and mixtures thereof. These ethoxylated amine compounds are useful in detergent compositions.

Detergent compositions which comprise from about 0.05 to about 95% by weight of a water-soluble ethoxylated amine having clay soil removal/anti-redeposition properties. These compounds are selected from ethoxylated monoamines, ethoxylated diamines, ethoxylated polyamines, ethoxylated amine polymers and mixtures thereof. In addition to the ethoxylated amines, the detergent compositions further comprise from about 1 to about 75% by weight of a nonionic, anionic, ampholytic, zwitterionic or cationic detergent surfactant, or mixture thereof. In addition to these detergent surfactants, the detergent composition can optionally comprise from 0 to about 80% by weight of a detergent builder.

EP 0 112 593 A3



European Patent
Office

EUROPEAN SEARCH REPORT

0112593

Application number

EP 83 20 1776

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
D, A	US-A-4 301 044 (G.E. WENTLER et al.) * abstract, claims 1-18 *	1	C 11 D 3/00 C 11 D 3/30 C 11 D 1/44 C 11 D 1/88
D, A	US-A-3 925 262 (R.G. LAUGHLIN et al.) * abstract, claims 1-11 *	1	
D, A	US-A-3 929 678 (R.G. LAUGHLIN et al.) * abstract, claims 1-5 *	1	
A	EP-A-0 032 837 (PROCTER & GAMBLE CO.) * abstract, claims 1-12 *	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
			C 11 D 3/00 C 11 D 1/00
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 27-05-1987	Examiner SCHULTZE D
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons</p> <p>& : member of the same patent family, corresponding document</p>			

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